only 95.7% twitch depression. However, seven of the nine receiving 0.1 mg/kg achieved 100% twitch inhibition. When we gave 0.15 mg/kg consecutively to nine additional patients, we observed 100% block in everyone. Our philosophy is that, when constructing dose-response curves, data should be included for all subjects in all dosage groups from the lowest exhibiting any measurable block to the first dose where all individuals show 100% block. Doses higher than this are not included. Thus, all individuals at the above included dosage levels who show 100 or 0% block contribute to the curve. In constructing our curve using the log-probit transformation, we arbitrarily assign a value of eight probits to 100% block and two probits to 0% block. We feel it is important to include all these individuals in constructing the curve, because this gives a better estimate of the true population mean at any ED in the curve, especially at the upper end. For clinical purposes, ED_{95} and higher EDs are pertinent because they define doses required for tracheal intubation. If 0 and 100% responders are not included in dosage *groups* where less than 100% block is noted, then the *slope* of the curve is made shallower, thus overestimating higher EDs such as the ED_{95}. An underestimate in this part of the curve would constitute a clinically relevant inaccuracy, since many patients would react strenuously to attempted intubation under these circumstances!

Our data generally show ED95s that are slightly higher than other studies done in similar fashion. For example, the ED_{95} values for mivacurium in studies done in Pittsburgh, San Francisco, and Iowa City[3-5] were 0.070, 0.067, and 0.075 mg/kg, respectively. These slight differences may very well be due to subtle differences in technique, such as fixation of the arm and hand, positioning of transducer, etc.

It is also worth pointing out here that the use of *median* doses as another indication of population sensitivity to relaxants should be considered. The median will skew the data toward a value that appears frequently. For example, the median response for mivacurium at 0.1 mg/kg is 100% block (since seven of nine subjects reached this level), and the ED_{95} derived from the median responses at all doses is 0.08 mg/kg.

We offer this commentary as a more detailed explanation of our method and philosophy of handling the data. We feel that other methods of handling the data, such as linear regression and logit transformation, also provide useful estimates. We do feel, however, that further debate over the issue of inclusion or exclusion of 0 and 100% responses would be particularly useful. Standardization of the methodology would be particularly important.

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Midazolam in a Malignant Hyperthermia-susceptible Patient

To the Editor:—Malignant hyperthermia (MH) is a serious and potentially fatal disorder characterized by acidosis, rigidity, and hyperthermia. Succinylcholine and the halogenated inhaled anesthestics trigger MH,[1] while the benzodiazepines, such as diazepam, do not.[1,2] Midazolam, another benzodiazepine, has been used in 3 MH-susceptible patients without problem.[3] Each of these patients however, was given dantrolene (2.5 mg/kg) prior to the administration of midazolam. A midazolam-induced hyperthermic crisis may have been prevented by the dantrolene pretreatment.[4]

Midazolam was used safely in an MH-susceptible patient at this institution, without dantrolene pretreatment. The patient had previously suffered a hyperthermic crisis during general anesthesia for a kidney transplant, characterized by hyperthermia, hypercarbia, and cardiac arrest. He was successfully treated with dantrolene and survived without sequelae. He was subsequently admitted for core decompression of the right hip, and was given spinal anesthesia with 13 mg tetracaine in 1.3 ml 10% dextrose, with 0.1 ml epinephrine. No known triggering agents were used. A total of 4 mg midazolam was given for intraoperative sedation with good result. His vital signs remained stable both intraoperatively and postoperatively, and he was discharged 48 h after the operation in satisfactory condition.

As a benzodiazepine, midazolam would not be expected to trigger MH. *In vitro* studies of midazolam in biopsied muscle preparations corroborate this hypothesis.[5] In the absence of dantrolene pretreatment, it is reasonable to assume that midazolam was used safely and did not trigger an MH crisis. Further reports, however, will be necessary to firmly establish that midazolam is not a triggering agent of MH.

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Exchange Autotransfusion Using the Cell Saver during Liver Transplantation

To the Editor:—The use of blood salvage techniques to reduce demand for banked red blood cells and minimize the risk of transfusion-transmitted diseases is well accepted during most surgical procedures. However, the role of the cell saver is controversial in patients undergoing liver transplantation.[1] Potential risks of heparinization or contamination of salvaged blood from the abdomen has only recently been evaluated.[2]

Patients presenting for liver transplantation may be in severe hepatic and renal failure, resulting in extremely high serum levels of ammonia, lactate, potassium, and other products of catabolism, despite preoperative dialysis. Intraoperative plasma ultrafiltration (and partial dialysis) can be continued utilizing a continuous arteriovenous hemofiltration device.[3] Rapidly infused banked red blood cells may cause lethal elevations in serum potassium. This can be ameliorated either with preoperative laboratory cell washing,[4] which is time-consuming and expensive, or with intraoperative processing with the cell-saver.[5]

Despite all of these measures, high serum levels of ammonia, lactate, and potassium can still occur. These problems are compounded at the time of hepatic graft reperfusion, when a considerable acid and potassium load may be flushed into the systemic circulation. This may result in severe hemodynamic compromise, potentially causing cardiac arrest or loss of the newly grafted organ. To reduce this risk, serum levels of these catabolites could effectively be lowered during the anhepatic phase of the transplantation by exchange transfusion.

We were able to effectively "exchange autotransfuse" a 62-yr-old male in fulminant hepatic and renal failure using the cell saver (Haemonetics Cell Saver System III), during the anhepatic phase of a liver transplantation. The patient had been hemodialyzed preoperatively, and a continuous arteriovenous hemofiltration device had been inserted *via* the femoral vessels; however, ammonia and lactate serum levels remained elevated. The patient's blood was withdrawn in sterile fashion *via* regulated suction applied directly to an 8 Fr. jugular venous catheter, and drained into the cardiotomy reservoir of the cell saver. This was then washed with normal saline and reinfused, along with a like quantity of washed banked red blood cells, to a total of 5000 cc. Additional plasma components and calcium were replaced as indicated by laboratory values and the thromboelastograph. Table 1 shows the effectiveness of the cell saver in removing ammonia, lactate, and potassium. We also tested banked red blood cells, and the levels obtained from similar processing in the cell saver; these are also shown in table 1. These results generally agree with those of others.[5]

Graft reperfusion was well tolerated, and the case concluded uneventfully, with good evidence of a functioning hepatic graft.

We believe that this provides a new and potentially valuable application of autotransfusion technology, and one which merits more intensive investigation.

TABLE 1. Electrolyte Changes with Cell-saver Processing

Serum Values (Normals)	—Patient's Blood— *In Vivo* Pre-CSP	*In Vitro* Post-CSP	*In Vivo* Post-CSP	Banked PRBCs Pre-CSP	Post-CSP
Ammonia (15–40 μm/l)	85	40	43	693	92
Lactate (0.5–2.2 mm/l)	16.4	5.1	5.9	24.8	10.6
Potassium (3.5–5.0 meq/l)	4.2	1.1	3.6	>30	1.3

CSP = cell saver processing; PRBC = packed red blood cells.

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